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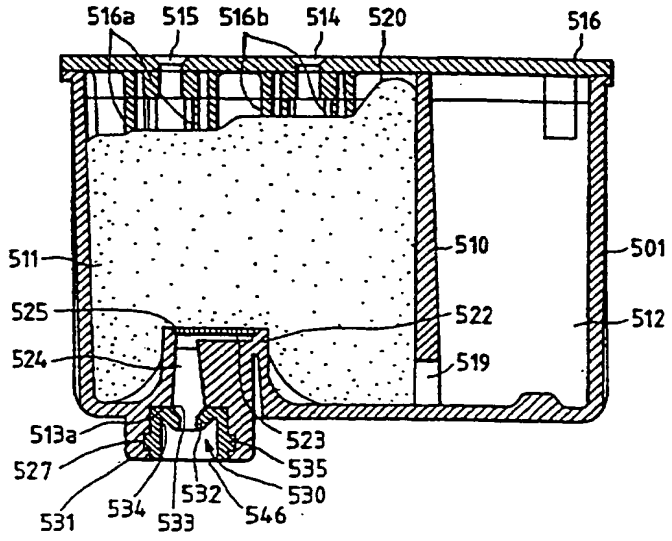
(54) Multi-colour ink cartridge having an enlarged supply port

(57) The vented cartridge has an ink chamber 512 and a foam chamber 511 divided by a partition wall 510. The chambers are connected by a hole 519 extending along the bottom of the wall away from the lateral extremes thereof. A supply port (513,Fig.3) protrudes into the foam chamber through the chamber's bottom wall and terminates in an enlarged bore 523 compared with the tapered bore formed by a resilient packing member 530.

FIG. 2



GB 2315461 A

FIG. 1

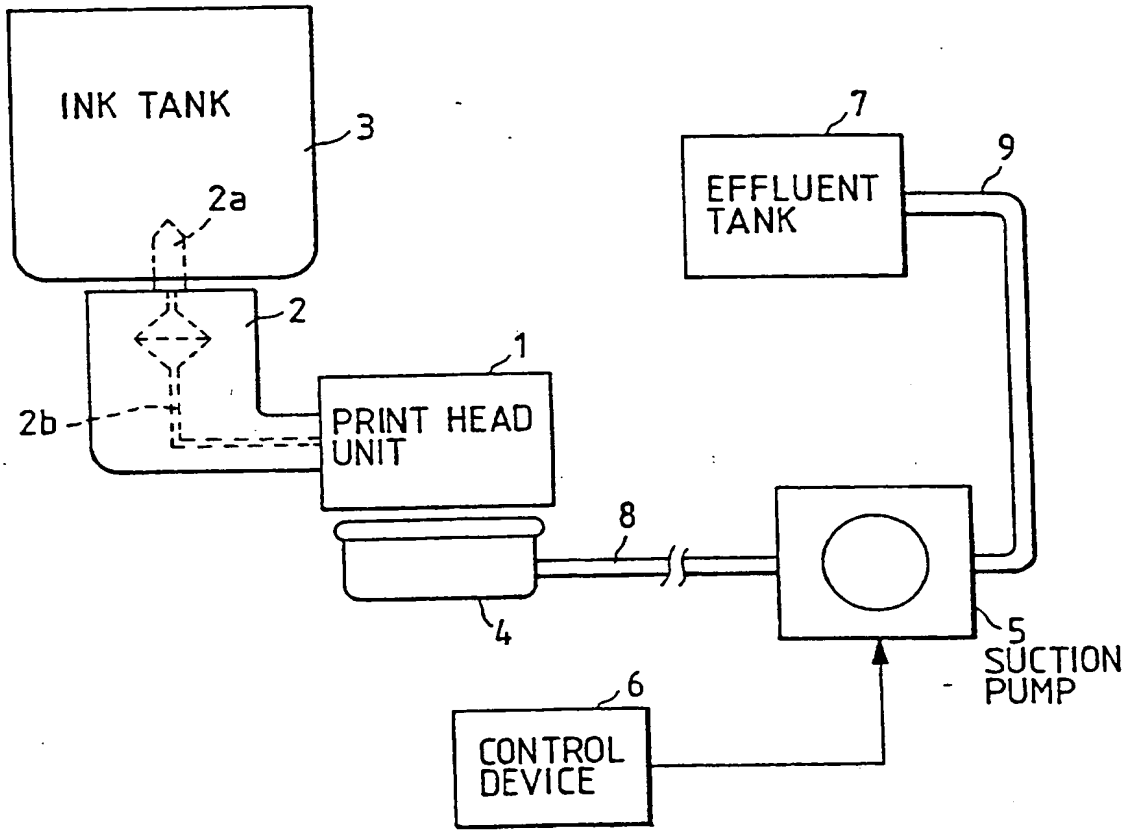

INK TANK
3
2a
2
2b
1
PRINT HEAD UNIT
4
8
7
EFFLUENT TANK
9
5
SUCTION PUMP
6
CONTROL DEVICE

FIG. 2

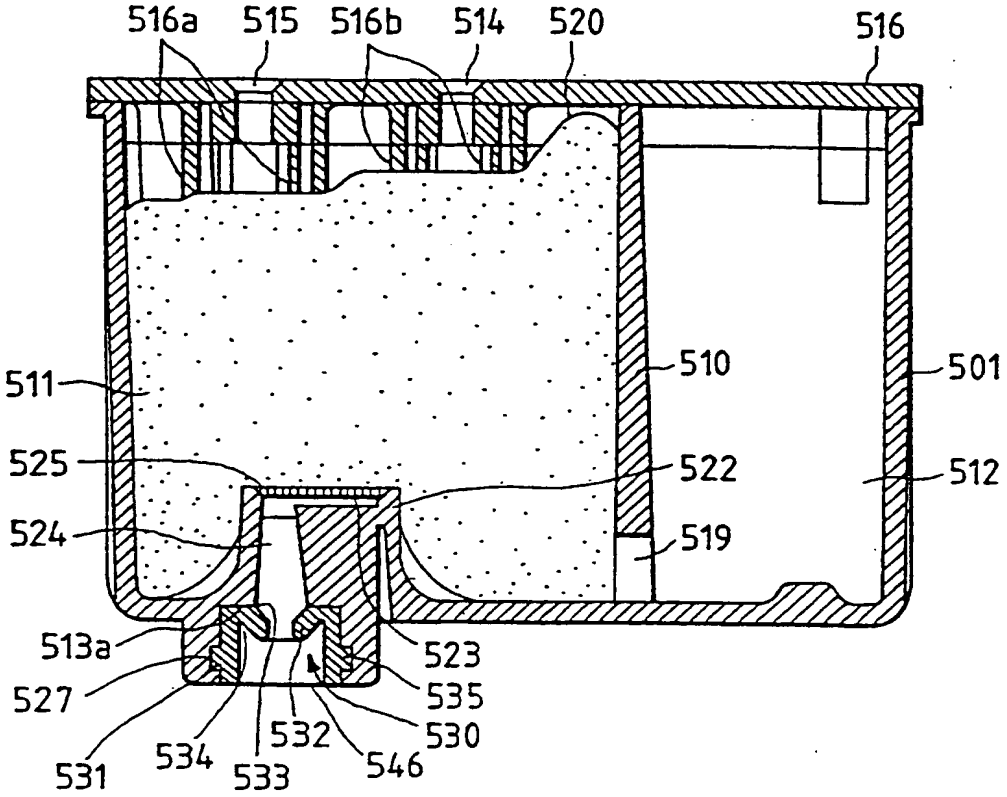

516a
515
516b
514
520
516
511
510
501
525
522
512
524
519
513a
523
527
535
530
531
534
533
532
546

FIG. 3

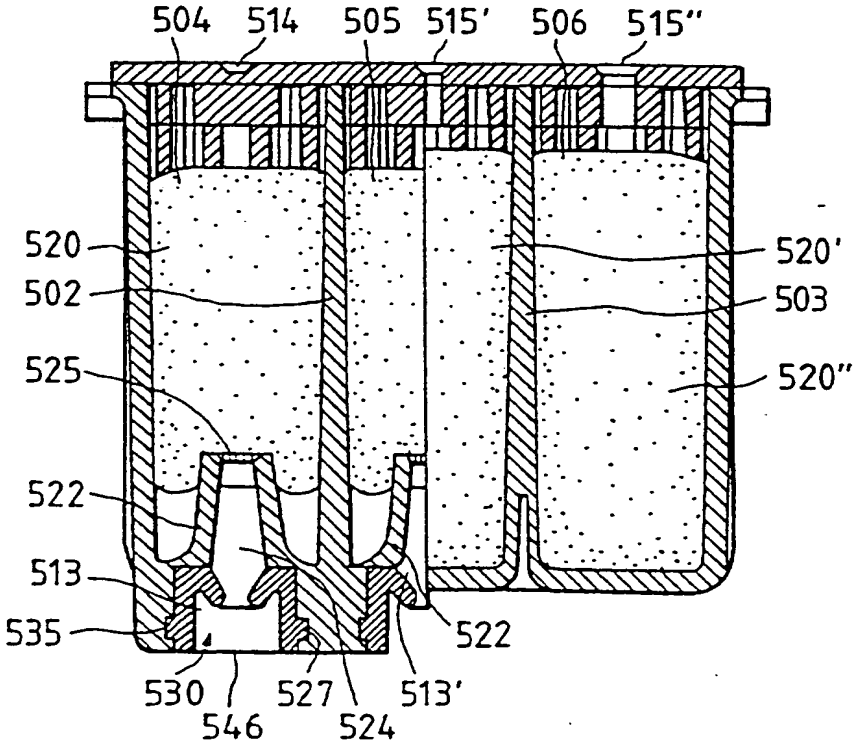

504
514
505
515'
506
515"
520
520'
502
503
525
520"
522
513
535
522
530
527
513'
546
524

FIG. 4

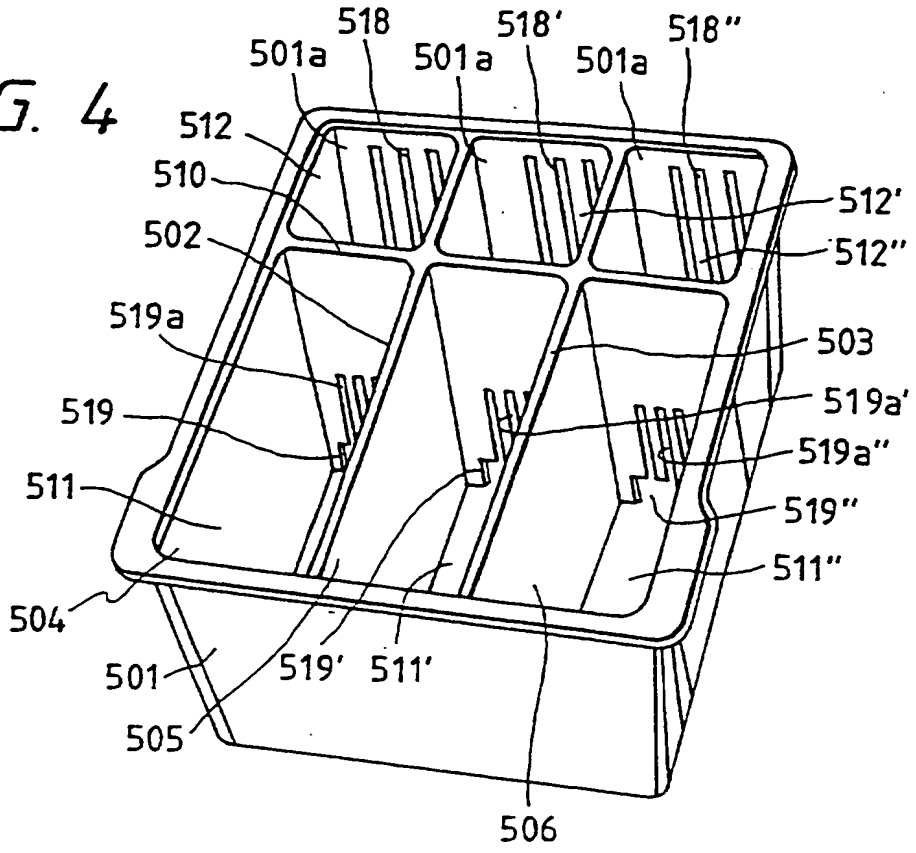

518
518'
518"
501a
501a
501a
512
510
502
519a
519
511
504
501
505
519'
511'
506
512'
512"
503
519a'
519a"
519"
511"

FIG. 5

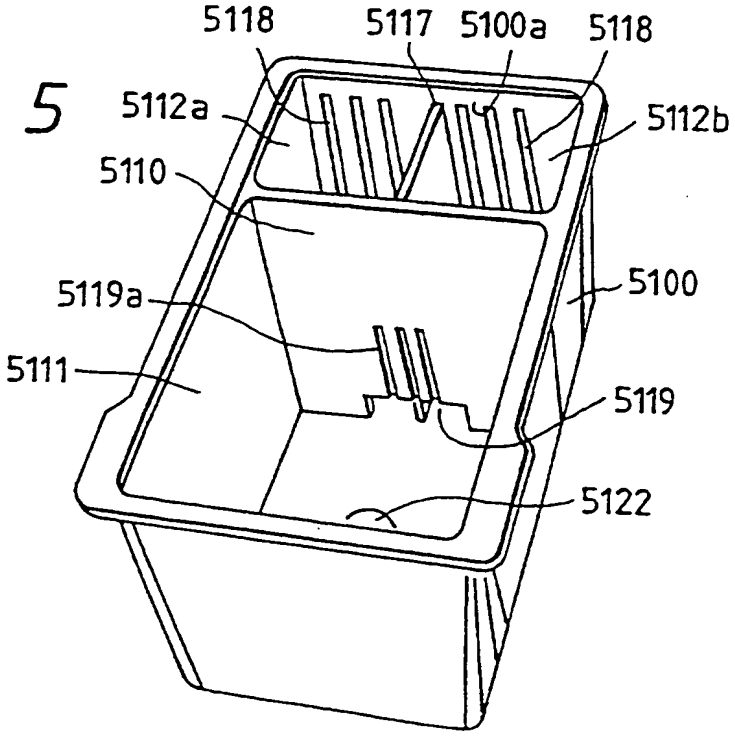

5118
5117
5100a
5118
5112a
5112b
5110
5119a
5111
5100
5119
5122

FIG. 6(a)

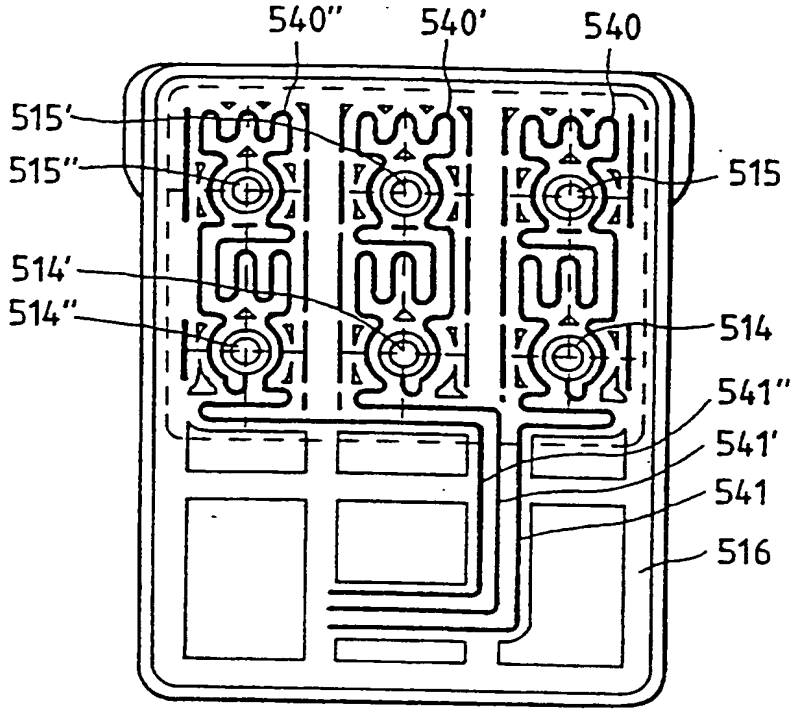

540"
540'
540
515'
515"
515
514'
514"
514
541"
541'
541
516

FIG. 6(b)

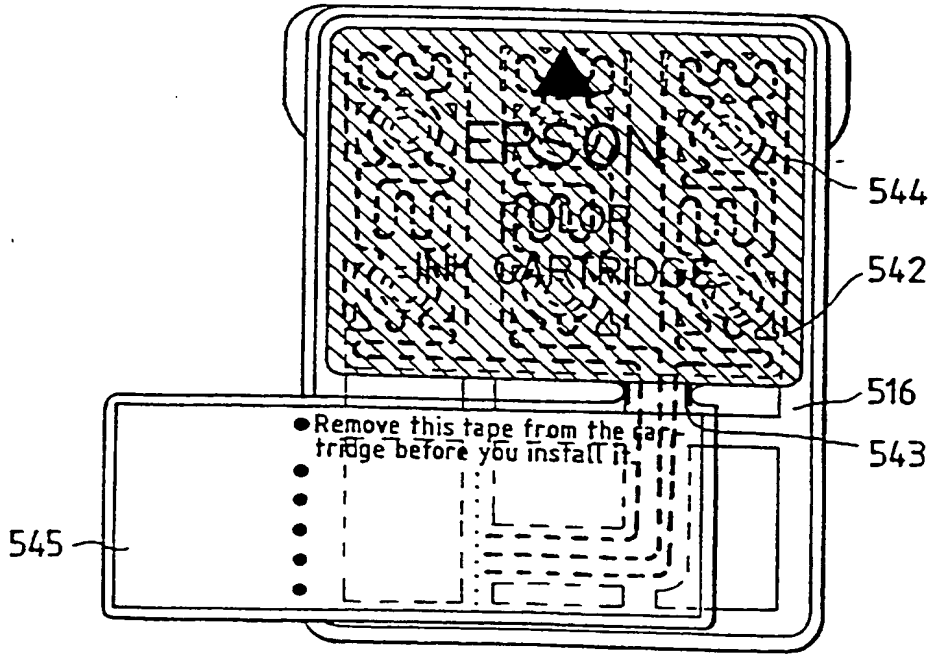

EPSON
COLOR
INK CARTRIDGE
544
542
516
543
Remove this tape from the cartridge before you install it.
545

FIG. 7(a)

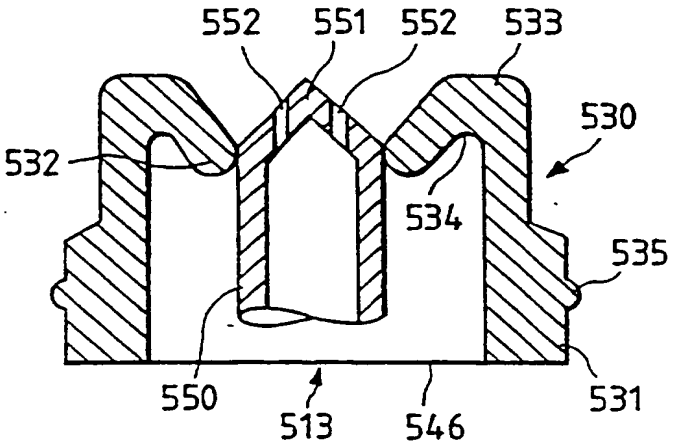

552
551
552
533
530
532
534
535
550
513
546
531

FIG. 7(b)

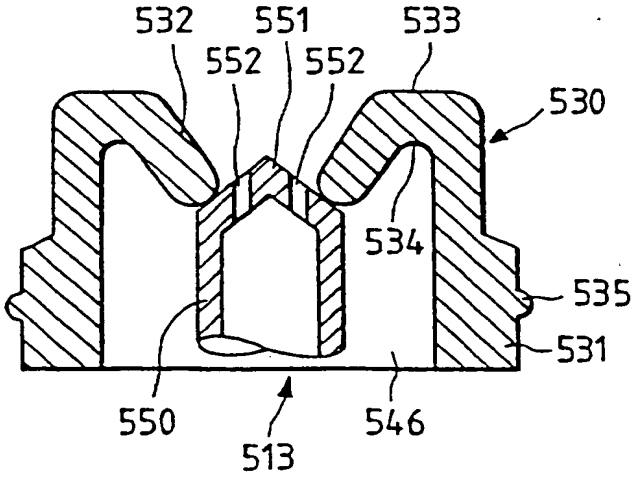

532
551
533
552
552
530
534
535
531
550
513
546

FIG. 8

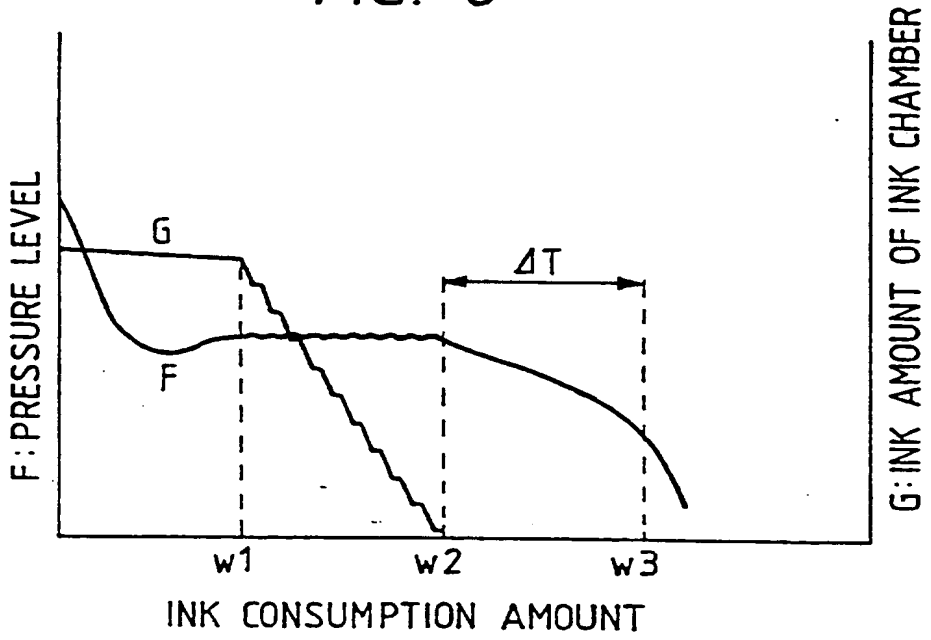


FIG. 15

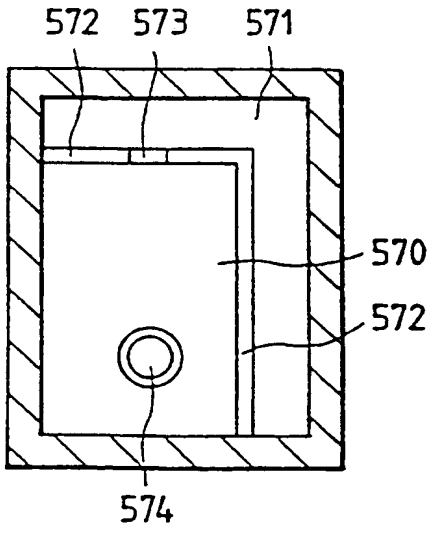


FIG. 16

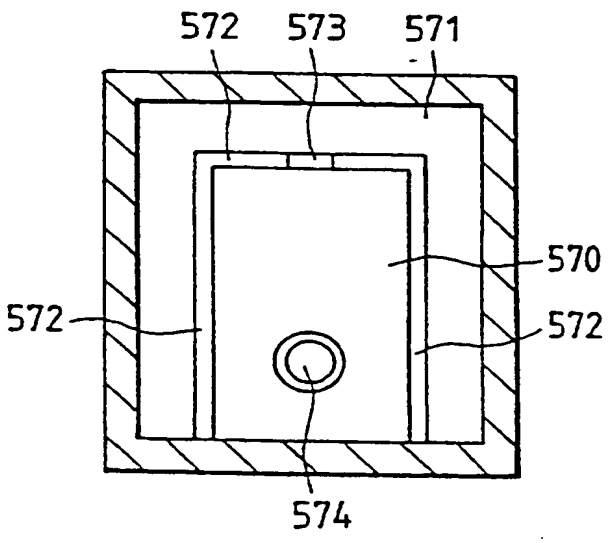


FIG. 9

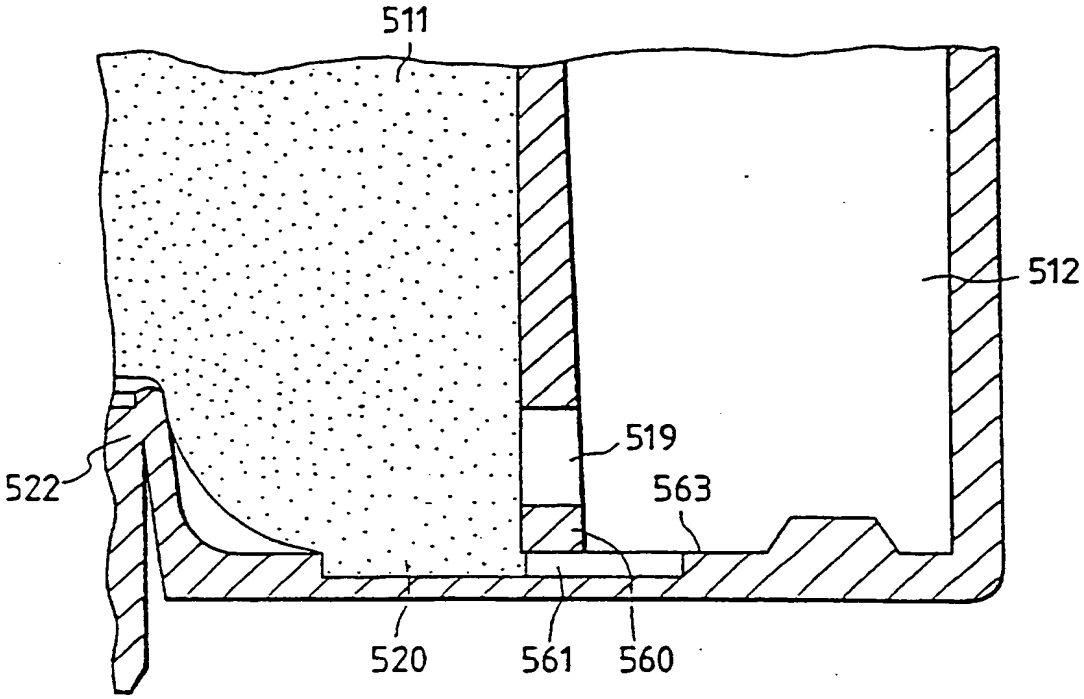

511
512
519
563
522
520
561
560

FIG. 10

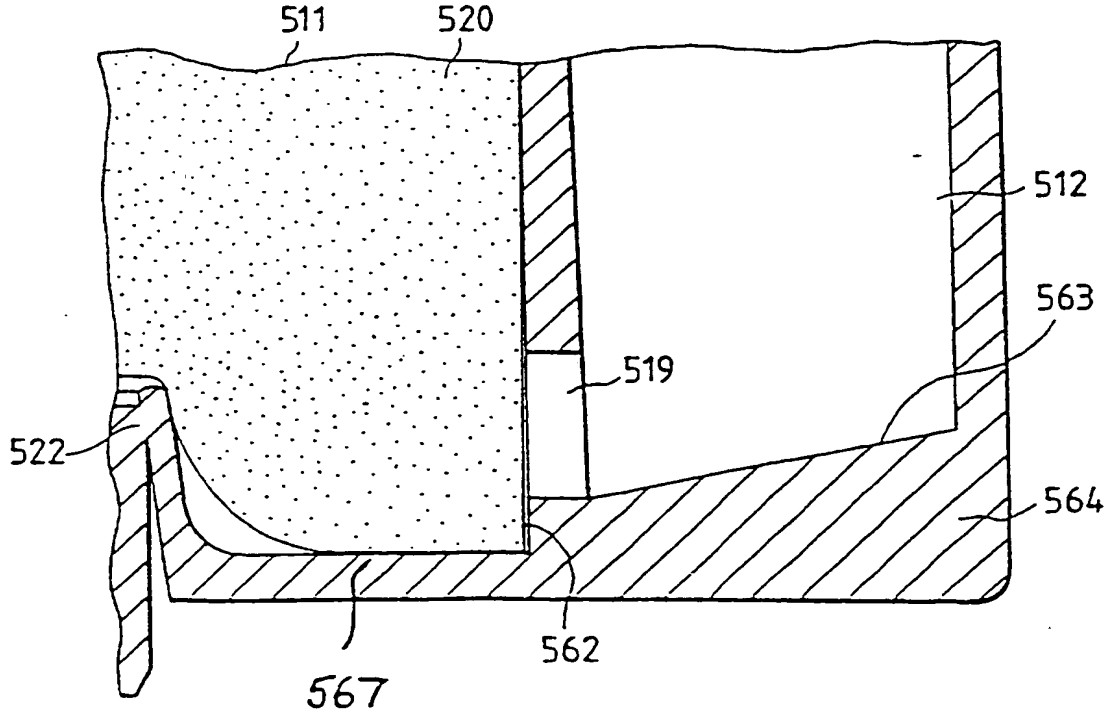

511
520
512
563
519
522
564
562
567

FIG. 11

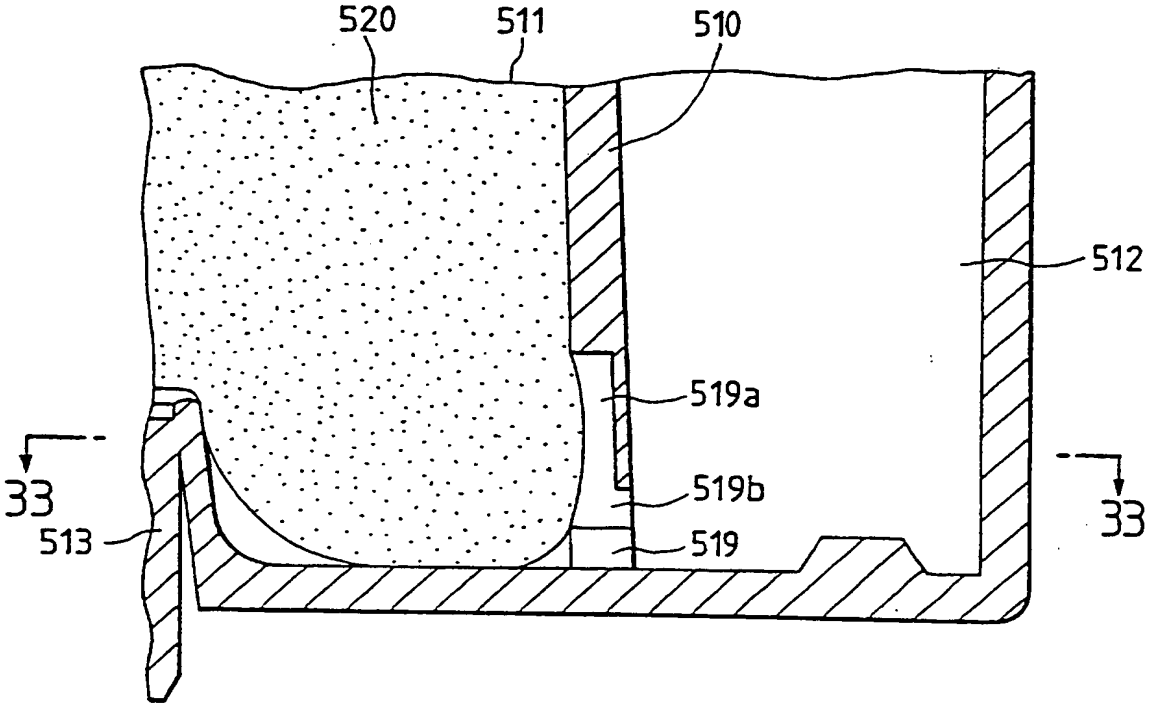


FIG. 12

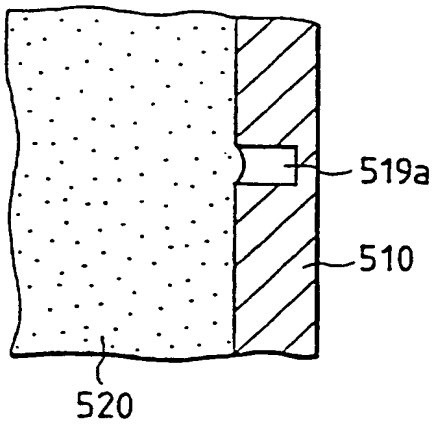


FIG. 13

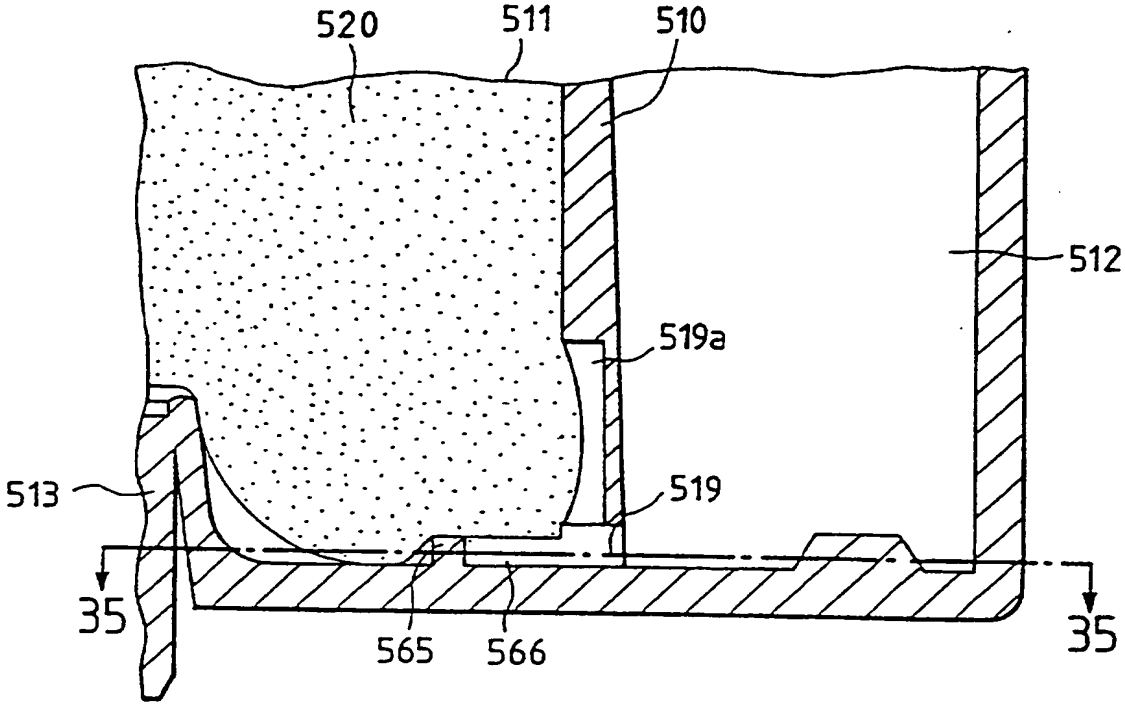


FIG. 14

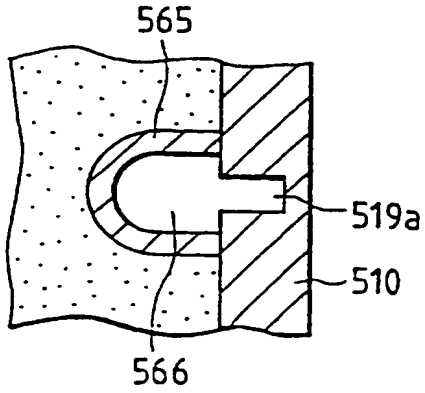


FIG. 17

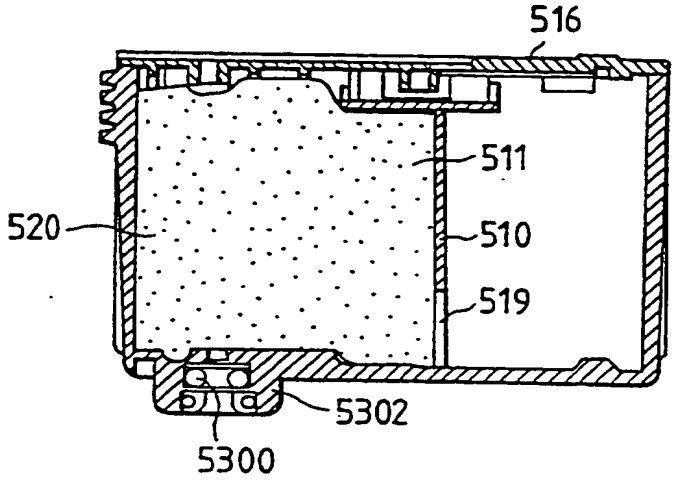
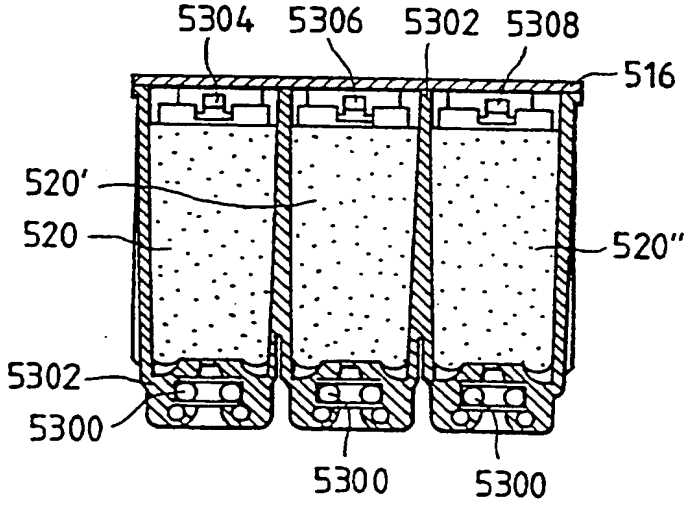

516
511
520
510
519
5302
5300

FIG. 18


5304
5306
5302
5308
516
520'
520
520"
5302
5300
5300
5300

2315461

INK TANK CARTRIDGE FOR A PRINTER OR THE LIKE

The present invention relates generally to an ink-supplied printer being supplied with ink from an ink supply tank and more particularly to an ink supply tank which allows for the continuous supply of ink to the printer head while avoiding adverse effects from temperature, atmospheric changes or vibrations.

This invention also relates to an ink cartridge for an ink jet printer in which an ink jet recording head, and an ink cartridge are mounted on a movable carriage, and in particular an ink jet cartridge which, upon depletion of the ink from the old cartridge, is replaced with a new ink cartridge.

Objects, features and advantages of the present invention will become apparent from the following description when taken in conjunction with the accompanying drawings in which preferred embodiments of the present invention are shown by way of illustrative example and not in a limiting sense.

In accordance with a first aspect of the present invention there is provided an ink tank cartridge for an ink-jet type recording apparatus, comprising:

a chamber;

an ink supply port extending through a wall of said chamber and supplying ink to the exterior of said cartridge;

a porous member in said chamber positioned to deliver ink to the ink supply port; and

a plurality of projections formed on an inside wall of said chamber disposed on a surface of said chamber opposite said ink supply port, said projections compressing said porous member against said ink supply port and at least one projection directly opposed the ink supply port being formed with its free end located at a position closer to the ink supply port than the free end of a projection or projections not directly opposite the ink supply port, whereby the portion of porous member in the vicinity of the ink supply port is compressed to a greater extent than the portion of porous member remote from the ink supply port.

According to a second aspect of the present invention, there is provided an ink tank cartridge for an ink-jet type recording apparatus, comprising:

a first chamber;

a second chamber;

a partition wall disposed in said cartridge and being formed with a communicating hole formed therein disposed between said chambers, said communicating hole extending along a relatively small portion of the bottom of said partition wall substantially away from the lateral extremes thereof, said second chamber communicating with said first chamber through said communicating hole;

an ink supply port extending through a bottom wall of said second chamber, projecting into said second chamber and supplying ink to the exterior of said cartridge, said ink supply port terminating within the second chamber in an enlarged internal bore compared with the bore passing through the said bottom wall;

a porous member in said second chamber positioned to deliver ink to the ink supply port; and

an air vent port communicating between said second chamber and the exterior of said cartridge at a location spaced from said ink supply port and communicating hole.

According to a third aspect of the present invention, there is provided an ink tank cartridge for an ink-jet type recording apparatus, comprising:

a first chamber;

a second chamber;

a partition wall disposed in said cartridge and being formed with a communicating hole formed therein disposed between said chambers, said communicating hole extending along a relatively small portion of the bottom of said partition wall substantially away from the lateral extremes thereof, said second chamber communicating with said first chamber through said communicating hole;

an ink supply port extending through a bottom wall of said second chamber, projecting into said second chamber and supplying ink to the exterior of said cartridge,

said ink supply port terminating within the second chamber at a height which is above the highest extreme of the said communicating hole;

a porous member in said second chamber positioned to deliver ink to the ink supply port; and

an air vent port communicating between said second chamber and the exterior of said cartridge at a location spaced from said ink supply port and communicating hole.

According to a fourth aspect of the present invention, there is provided an ink tank cartridge for an ink-jet type recording apparatus, comprising a housing with an ink supply port extending through an external wall thereof for supplying ink from the housing to the exterior thereof, wherein a funnel-shaped packing member is provided within the ink supply port, the member having a tapered bore for receiving an ink supply needle of an ink recording apparatus and resiliently abutting there against so as to form a seal.

Reference is hereby made to British patent application 9519062.5 from which this application is a divisional application and to British patent applications 9519071.6 and 9519047.6 which both describe arrangements similar to those of the illustrated embodiments herein.

Generally speaking, there is provided an ink-supplied printer. Ink is supplied to a printer head by an ink supply system, including an ink tank having an ink supply port and a pair of side walls. An ink absorbing member is contained therein adjacent the ink supply port which occupies less than the total volume of the ink tank.

The walls of the ink supply tank may be transparent so the user can more easily determine the amount of ink remaining in the ink supply tank.

An ink receiving and transferring member terminating in an ink port may extend into the ink tank, in which case the ink absorbing member abuts and is locally compressed by the ink receiving and transmitting member. The ink receiving and transmitting member has a capillary ink path communicating with the printer head and is supplied with ink from the ink absorbing member.

More specifically an ink cartridge may be formed of an ink chamber for storing ink and a foam chamber for receiving a porous member for absorbing ink. A partition separates the ink chamber from the foam chamber and has a hole therein so that the foam chamber is in fluid communication with the ink chamber. The ink cartridge is also formed with an ink supply port. A funnel shaped packing member is disposed within the supply port and supplies ink to a recording head by generation of a pressure difference through the porous member. The packing member is disposed facing upward in the ink supply port. The packing member is resilient.

When an ink supply needle of the recording head is inserted into the ink supply port, the tip of the needle may resiliently contact the packing member. Since the packing member has a funnel-like shape which opens upward, the packing member is easily deformed so as to follow the ink supply needle. Furthermore, the packing member is caused to closely contact with the needle by its resiliency. Therefore, a relative misalignment between the ink supply needle and the ink supply port can be accommodated so that the ink supply port is securely sealed.

The invention accordingly comprises the several steps and relation of one or more of such steps with respect to each of the others, and the apparatus embodying features of construction, combinations of elements and arrangement of parts which are adopted to effect such steps, all as exemplified in the following detailed disclosure, and the scope of the invention will be indicated in the claims.

For a better understanding of the invention, embodiments will now be described by way of example with reference to the accompanying drawings, in which:-

Figure 1 is a schematic view showing an ink supply system of an ink-jet type recording apparatus according to one embodiment of the present invention;

Figure 2 is a cross-sectional view of a multi-colour ink jet printer cartridge constructed in accordance with a first embodiment of the invention;

Figure 3 is a cross-sectional view of the first embodiment rotated 90° from the view in Figure 2;

Figure 4 is a perspective view showing the ink cartridge of Figures 2 and 3 with the lid removed;

Figure 5 is a perspective view showing a single colour ink cartridge constructed in accordance with a second embodiment of the invention;

Figure 6(a) is a top plan view of the lid of Figure 2;

Figure 6(b) is a top plan view showing the lid with a seal affixed thereto;

Figure 7(a) is a cross-sectional view showing a packing member with an ink supply needle inserted therein;

Figure 7(b) is a cross-sectional view of the packing member prior to insertion;

Figure 8 is a graph showing the relationships of the ink consumption, the pressure level, and the amount of ink remaining in an ink chamber;

Figure 9 is a partial cross-sectional view of the ink cartridge showing the boundary between ink and foam chambers in accordance with a third embodiment of the invention;

Figure 10 is a partial cross-sectional view of the ink cartridge showing the boundary between ink and foam chambers in accordance with a fourth embodiment of the invention;

Figure 11 is a partial cross-sectional view of the boundary between ink and foam chambers of an ink cartridge constructed in accordance with a fifth embodiment of the invention;

Figure 12 is a cross-sectional view taken along line 33-33 of Figure 11;

Figure 13 is a partial cross-sectional view showing the boundary between ink and foam chambers of an ink cartridge constructed in accordance with a sixth embodiment of the invention;

Figure 14 is a cross-sectional view taken along line 35-35 of Figure 13;

Figure 15 is a cross-sectional view showing an ink cartridge constructed in accordance with a seventh embodiment of the invention;

Figure 16 is a cross-sectional view showing an ink cartridge constructed in accordance with a eighth embodiment of the invention;

Figure 17 is a cross-sectional view showing an ink cartridge for an ink jet printer constructed in accordance with a ninth embodiment of the invention; and

Figure 18 is a cross-sectional view of the ninth embodiment of the invention rotated 90° from Figure 17.

An embodiment of the printer head according to the present invention may be used in a four-colour printer plotter or colour image printer and has four-colour ink systems and ink jets corresponding respectively to four ink colours. The four-colour printer plotter employs black, red, green and blue inks, and moves the head or a sheet of print paper or both and then ejects ink as in a conventional ink jet print head, corresponding to a desired one of the colours against the print paper at a prescribed position thereon to form an ink dot. Desired characters and figures can thus be recorded by repeating the above cycle. The present invention is applicable to ink jet printers of all varieties, including print heads using heat from heated resistors or the like or the displacement of piezo-electric members or with transducers to project a drop of ink from a chamber upon application of a print signal. The ink supply tanks according to the invention may supply ink continuously to said chambers through capillary paths.

In a colour image printer using inks of four colours, that is, black, red, green and blue, a sheet of print paper is scanned by a printer head in a direction perpendicular to the direction of feed of the print paper to form one-dot line in one scanning stroke, and the print paper is fed along by line pitches to record images. In seven-colour printers, inks of four colours, that is, black, yellow, magenta and cyan, are used, and the colours of red, green and blue are formed on a sheet of print paper by superimposing inks of two out of the three desired colours other than black, thereby recording colour images of seven colours.

The present invention is concerned primarily with the printer head, and more particularly, but not exclusively, with the ink tanks, and detailed description of the overall printer construction will be given only by way of a single example.

Figure 1 is a schematic view showing an ink supply system of an ink-jet type recording apparatus according to one embodiment of the present invention.

A print head unit 1 of an ink-jet type is connected to an ink tank 3 through a connecting member 2. Ink is supplied from the ink tank 3 to the print head unit 1 through a hollow needle 2a and an ink supply passage 2b of the connecting member 2, so that the print head unit 2 emits ink droplets in accordance with print signals.

The apparatus shown in Figure 1 also includes a cap member 4 disposed at non-printing area, which cap member comes into abutment against the nozzle plate of the print head unit 1 by a drive mechanism (not shown) for preventing the nozzle openings from drying. The cap member 4 is connected through a tube 8 to a suction pump 5 which is operated by a control device 6 to suck ink from the print head unit 1 through the cap member 4. The apparatus shown in Figure 1 is also provided with an effluent tank 7 connected to an outlet port of the suction pump 5 through a tube 9.

The recording head may be of any structure such as described in European Patent Publication Nos. 581,531, 609,863, 584,823 and so on.

The ink cartridge is configured so as to be mounted with a small force and to accommodate a misalignment of a certain degree. Reference is first made to Figures 2 and 3 which depict an ink cartridge constructed in accordance with a first embodiment of the invention. A main container 501 is divided into three compartments 504, 505 and 506 by partitions 502 and 503 as shown in Figure 3. Each of the three compartments 504, 505 and 506 is divided by a centre partition wall 510 into foam chambers 511, 511' or 511" housing a respective porous member 520, 520' or 520" and ink chambers 512, 512' or 512" which are adapted to contain liquid ink. Foam chambers 511, 511', 511" are dimensioned to receive a respective porous member 520, 520', 520".

The volume of each of porous members 520, 520' and 520" is selected so as to be larger than the capacity of each of the respective foam chambers 511, 511' or 511", so as to be compressed while being retained in the respective foam chamber in a preferred embodiment. The ratio of the capacities of each foam chamber 511, 511' or 511" and each ink chamber 512, 512' or 512" is selected so that each foam chamber 511, 511' or 511" is dimensioned to hold 20 to 30% more ink than the respective ink chamber 512, 512' or 512".

When inks of three colours are contained within a single cartridge as in Figures 2 to 4, it may be difficult to see if different amounts of ink remain in the chambers, which may be caused by unbalanced consumption of the different colour inks. When ink of one colour is depleted, and the user wishes to dispose of the cartridge, the user need not unnecessarily worry about any remaining ink of the other colours in the cartridge leaking. When a cartridge is disposed of, ink is prevented from flowing out of the cartridge because ink of each colour is absorbed by each respective porous member, thereby protecting the environment from any leakage of ink.

Ink supply ports 513, 513' and 513" of each chamber (only one of the ports is shown in the drawings, chamber 511 being exemplary of each chamber 511, 511' and 511") are formed in main container 501 within a respective foam chamber 511, 511' and 511". Each ink supply port 513, 513' and 513" is adapted to engage with a respective ink supply needle (not shown) of the recording head which are inserted at the lower end of each of the foam chambers 511, 511' and 511".

Referring now to Figures 2 and 3, the upper end of the main container 501 is sealed by a lid 516. Two ink filling ports 514 and 515 are formed at positions on lid 516 corresponding to foam chamber 511. Similarly, as shown in Figure 6(a), each chamber 511, 511' and 511" includes corresponding ink filling ports 514 and 515, 514' and 515', and 514" and 515". Projections 516a and 516b, Figure 2, are integrally formed with the inner surface of lid 516 and are positioned in foam chamber 511, so as to surround filling ports 515 and 514, respectively. Porous member 520 is compressed by projections 516a and 516b against the bottom wall of foam chamber 511 in which ink supply port 513 is formed. Projections 516a' and 516b' and 516a" and 516b" are similarly formed in the inner wall of lid 516, and are positioned in foam chambers 511' and 511", which contain ink supply ports 513' and 513", respectively, as shown in Figure 3.

Projection 516a which opposes ink supply port 513 is formed with its lower tip located at a position lower than the lower tip of projection 516b, whereby the portion of

porous member 520 in the vicinity of ink supply port 513 is compressed to the greatest extent.

Protrusion portions 522, 522' and 522" (collectively "522"), which cooperate with lid 516 to compress porous members 520, 520' and 520" respectively are formed on the bottom of each of foam chambers 511, 511' and 511". Recesses 523, 523' and 523" (collectively "523"), which define spaces having a fixed opening area, are formed at the upper end of respective protrusion portions 522. Through holes 524, 524' and 524" (collectively "524") are disposed within the respective protrusion portions 522. One end of each through hole 524 is in fluid communication with the spaces defined by recesses 523 and the other end with a respective packing (collectively "530"), which will be hereinafter described. Filters 525, 525' and 525" (not shown) (collectively "525") are fixed to the upper end of recesses 523 respectively.

Packing members 530, of which only one is shown, are disposed at the lower end of ink supply ports 513, 513' and 513" respectively and are made of a resilient material such as rubber. Packing members 530, are configured as a funnel-shaped packing which opens upward. The lower ends of tubular portions 531 are thicker than the other portions. The respective upper peripheral edges 533 of taper portions 532 of respective packing members 530 contact with step portions 513a of respective ink supply ports 513, 513' and 513". Each packing member 530 is formed with protrusions 535 received by groove portion 527 within the inner wall of ink supply port 513. The boundary between tubular portions 531 and taper portions 532, are configured as thin connection portions 534.

In this design, packing members 530 are fixed by tubular portions 531 to respective ink supply ports 513. Additionally, upward movement of upper peripheral edges 533 is prevented by respective step portions 513a. Thus, even when the respective ink supply needle is inserted or extracted, packing members 530 are adequately fixed to ink supply ports 513. Since taper portions 532 serve to attain the hermetic seal between the packing member of the respective ink supply port 513 and the ink supply needle by the respective thin connection portions 534, the taper portions can be moved somewhat

without causing deformation. Consequently, the air tight seal between the respective packing member and ink supply needle can be maintained while accommodating a relative misalignment between the respective ink supply needle and ink supply port.

Communicating holes 519, 519' and 519" are formed in centre partition wall 510, which separates foam chambers 511, 511' and 511" from ink chambers 512, 512' and 512" respectively. Slots 519, 519a' and 519a" which extend to a predetermined height are formed to be in communication with communicating holes 519, 519' and 519" respectively for gas-liquid replacement. Between each respective pair of foam and ink chambers 511 and 512, 511' and 512', and 511" and 512", porous members 520, 520' and 520" are housed in the foam chambers 511, 511' and 511" respectively in such a manner that each porous member is held against the respective communicating hole 519, 519' and 519". Ribs 518, 518' and 518" are formed on a back wall 501a of container 501 within a respective ink chamber 512, 512' and 512". An individual communication hole is formed between each respective chamber pair 511, 512, and extends along only a portion of the length of partition 510 formed thereat.

In a second embodiment of the invention an ink cartridge is utilized for a single colour ink. A cartridge 5100 for a single colour, or black ink can be made smaller in size than that for colour inks, but the ink chamber 5112 for black ink would have a larger capacity than each of the corresponding chambers for a colour ink. According to the second embodiment of the invention, a cartridge for black ink is shown in Figure 5 having a partition wall 5117 formed within a container 5100 so as to extend between centre partition wall 5110 which separates a foam chamber 5111 from-an ink chamber 5112 and a side wall 5100a of main container 5100, thereby dividing ink chamber 5112 into two cells 5112a and 5112b. This structure prevents container 5100 from being deformed by a negative pressure produced during the ink filling process which will be hereinafter described, or by an external pressure during usage, thereby preventing any ink from leaking. Cells 5112a and 5112b are retained in fluid communication with foam chamber 5111 via a communicating hole 5119 in centre partition 5110 which extends

along only a portion of the length of partition 5110. In addition, a communicating hole may be formed in the lower portion of partition wall 5117.

On the inner face of wall 5100a, which can easily be seen when the cartridge is mounted on a carriage, a plurality of ribs 5118 are formed which extend vertically along inner face 5100a. These ribs allow ink to flow more easily down along wall 5100a, and the user can easily recognize the amount of ink remaining in the cartridge by seeing the ink level.

Reference is now made to Figures 6(a) and 6(b) which depict lid 516 constructed in accordance with the first embodiment of the invention. Ink filling holes 514, 514' and 514", and 515, 515'' and 515" are formed in the regions of lid 516 corresponding to the placement of porous members 520, 520' and 520" within container 501. Air communicating ports 541, 541' and 541" are connected to ink filling holes 514, 514' and 514" via grooves 540, 540' and 540", respectively.

When a seal 542 for covering ink filling holes 514, 514' and 514", 515, 515' and 515", and air vent ports 541, 541' and 541" is fixed to the upperside of lid 516, Figure 6(b), after ink from chambers 511, 511' and 511" are filled, grooves 540, 540' and 540" form capillary tubes with seal 542. A tongue piece 545 of seal 542, which protrudes from lid 516, is formed with a neck portion 543 disposed in seal 542 at a midpoint of the route of air vent ports 541, 541' and 541". When tongue piece 545 is peeled from lid 516, tongue piece 545 is easily separated from seal 542. This in turn exposes air vent ports 541, but no other portions of the underside of seal 542.

In a preferred embodiment, seal 542 is formed with patterns such as characters and illustrations printed on its main portion 544 which permanently seals grooves 540, 540' and 540". Patterns, colours, or other printing different from that printed on main portion 544 of seal 542 may be placed on tongue piece 545 which is connected to main portion 544 of seal 542 via neck portion 543.

For example, in a further preferred embodiment, the main portion 544 of seal 542 has a blue background, black characters and other illustrations printed thereon. The background colour of tongue piece 545 is a colour such as yellow or red which contrasts

with the background colour of main portion 544. Characters and illustrations are printed on the background in colours which are mainly black or blue. In this way, main portion 544 and tongue piece 545 are distinguished from each other in colour and pattern. Consequently, it is possible to call the user's attention to the need for the removal of tongue piece 545.

Each of ink supply ports 513, 513' and 513" are sealed by a film 546 (Figure 2), and ink filling needles are hermetically inserted into the ink filling holes 514, 514' and 514" and 515, 515' and 515" respectively. The first of filling holes 514, 514' and 514" is connected to evacuating means, and the second of the filling holes 515, 515' and 515" is closed.

The evacuating means reduces the pressure in each of foam chambers 511, 511' and 511" and in each of ink chambers 512, 512' and 512". When the pressure is reduced to a predetermined value, the evacuating operation is stopped and the first filling hole is closed. Thereafter, the second filling hole is placed in fluid communication with a measuring tube filled with ink. Ink contained in the measuring tube is drawn into the evacuated container and is then absorbed by respective porous member 520, 520' and 520" and thereafter flows into ink chamber 512, 512' and 512" via communicating holes 519, 519' and 519" respectively.

After the specified amount of ink flows into the appropriate ink chamber, seal 542 is fixed to the outer surface of lid 516 so that the ink filling holes 514, 514' and 514" and 515, 515' and 515", grooves 540, 540' and 540", and communicating ports 541, 541' and 541" are sealed under reduced pressure. Seal 542 thereafter maintains the reduced pressure states of foam chambers 511, 511' and 511" and ink chambers 512, 512' and 512".

Before use of the cartridge, tongue piece 545 of seal 542 is then peeled off so that tongue piece 545 is broken at neck portion 543 and is separated from main portion 544. Thus, ink filling holes 514, 514' and 514" are placed in fluid communication with air vent ports 541, 541' and 541" via grooves 540, 540' and 540". Also, foam chambers 511, 511' and 511" are placed in fluid communication with air vent ports 541, 541' and

541" and therefore ambient air, via grooves 540, 540' and 540". Thus, while the ink is prevented from evaporating, the ink cartridge is ventilated.

Reference is now made to Figures 7(a) and 7(b), wherein an ink supply port 513 of the ink cartridge is positioned so as to be aligned with an ink supply needle 550 of the recording head. Thereafter the ink cartridge is pushed toward the recording head upon insertion of the ink cartridge. A taper portion 551 of ink supply needle 550 passes through a film seal 546 and engages the hole of packing member 530 as shown in Figure 7(a). Since packing member 530 opens upward, packing member 530 allows ink supply needle 550 to pass therethrough while packing member 530 is resiliently deformed by taper portion 551 of ink supply needle 550.

When the cartridge is used, ink supply needle 550 passes through packing member 530. The resiliency of connection portion 534 of packing member 530 enables taper portion 532 to engage ink supply needle 550. Even if ink supply needle 550 of the recording head and the centre of packing member 530 are somewhat misaligned, ink supply port 513 and ink supply needle 550 are hermetically sealed.

To conduct ink into the recording head after the ink cartridge is mounted, or to recover the ink ejection performance, a negative pressure is applied to the recording head and through ink supply needle 550 so that ink in the cartridge flows through ink supply needle 550 and into the recording head. Because of the pressure difference, this high negative pressure applied to the cartridge causes taper portion 532 of packing member 530, which hermetically seals and isolates the cartridge from ambient air, to deform upward in Figure 7(a) toward the interior of the ink cartridge. Thus, the pressure difference aids in causing taper portion 532 of packing member 530 to be resiliently pressed against ink supply needle 550, and thereby aids in hermetically sealing the ink cartridge.

Even if ink supply needle 550 is not positioned completely through packing member 530, the resilient force in taper portion 532 of packing member 530 allows taper portion 532 to remain in contact with ink supply needle 550 as long as the tapered portion 551 of ink supply needle 550 remains in contact with taper portion 532 as shown

in Figure 7(b). Consequently, it is possible to secure the air tightness of packing member 530 and ink supply needle 550 even if the needle is not properly inserted.

Since the tip of ink supply needle 550 is sealed upon contact with packing member 530, the dead space in the cartridge can be made very small, and any air bubbles which may be produced by the piston effect upon insertion of the cartridge onto the recording head are prevented from entering the cartridge.

When a negative pressure is applied from the nozzle openings of the recording head, ink absorbed by porous member 520 flows into the recording head via through hole 524 and through holes 552 of ink supply needle 550. When ink of a predetermined amount is consumed from porous member 520 and the ink level in porous member 520 is reduced, the pressure of ink chamber 512 overcomes the holding force of porous member 520 in the vicinity of communicating hole 519, so that air bubbles enter ink chamber 512 via communicating hole 519. Consequently, the pressure in an ink chamber 512 is increased and ink therefore flows into a foam chamber 511.

The ink flowing into foam chamber 511 is absorbed by porous member 520 and causes the ink level in foam chamber 511 to be raised. At the instant when the ink holding force of porous member 520 in the vicinity of communicating hole 519 is balanced with the pressure in ink chamber 512, the flow of ink from ink chamber 512 into foam chamber 511 is stopped.

The graph of Figure 8 illustrates this process. In the figure, the letter F indicates the pressure level in porous member 520 of foam chamber 511, and the letter G indicates the ink level in ink chamber 512. When a predetermined amount of ink w1 which was initially contained in porous member 520 is consumed so that the ink level in porous member 520 is reduced to a predetermined value at which the pressure in ink chamber 512 overcomes the ink holding force of porous member 520 in the vicinity of communicating hole 519, ink gradually flows in a stepwise manner from ink chamber 512 into the foam chamber 511. This process occurs until the balance between the pressure of the ink chamber 512 and the ink holding force of porous member 520 in the vicinity of communicating hole 519 is restored. As a result, although the ink level in ink

chamber 512 is gradually reduced, the ink level in porous member 520 can be maintained at a substantially constant level so that ink is supplied to the recording head by a constant pressure difference at a constant rate.

After a predetermined amount of ink w2 is consumed by the recording head, no ink will remain in ink chamber 512, but the amount of ink contained in porous member 520 will be at a level equal to the level when ink was intermittently being supplied to foam chamber 511 from ink chamber 512. Therefore, printing can be continued using the amount of ink absorbed in porous member 520, although no further ink is available in ink chamber 512 to replenish the ink supply into porous member 520. After a predetermined amount of ink w3 is consumed during printing, the ink supply in porous member 520 will be deleted, and the ink cartridge will no longer support printing.

During the entire printing operation from when all the ink contained in ink chamber 512 has been absorbed in porous member 520 until the ink is depleted, a constant amount of ink is supplied to the recording head. The depletion of ink from ink chamber 512 indicates the impending depletion of ink in the ink tank cartridge. If a fresh cartridge is inserted at this stage, it is possible to ensure a constant supply of ink to the recording head without interruption.

As described above, the inner space of the ink cartridge of the invention must be maintained at a negative pressure during the printing process. In addition to the achievement of the above-described hermetic seal between the ink supply port and the ink supply needle, the transfer of ink from ink chamber 512 to the foam chamber 511 must be performed properly to ensure a constant flow of ink to the recording head. Hereinafter, the structure for controlling the supply of ink from ink chamber 512 to foam chamber 511 will be described.

Reference is now made to Figure 9 which depicts the boundary between foam chamber 511 and ink chamber 512 in a third embodiment of the invention. Like numerals are utilized to indicate like structures, the primary difference between this embodiment and the first embodiment being a step portion formed in hole 519.

A step portion 560 is formed in communicating hole 519. A portion 563 of the base of ink chamber 512 is higher than that of foam chamber 511, step portion 560 being the dividing point. A groove 561 connecting the foam and the ink chamber is formed in the lower part of step portion 560.

Porous member 520 is in contact with communicating hole 519 and is received by step portion 560 so that the portion of porous member 520 in the vicinity of communicating hole 519 is compressed, whereby the required pressure difference between ink chamber 512 and foam chamber 511 via communicating hole 519 can be attained. When the ink level of ink chamber 512 is reduced to a low level, groove 561 enables ink from ink chamber 512 to be collected and then absorbed by porous member 520 in foam chamber 511. Consequently, all of the ink in ink chamber 512 can be supplied to the recording head for printing without wasting any ink.

Reference is now made to Figure 10, which depicts an ink cartridge constructed in accordance with a fourth embodiment of the invention. Again, like numerals are used to indicate like structures, the primary difference between this embodiment and the first embodiment is the different levelled bottoms of the respective chambers.

The bottom face 564 of ink chamber 512 is higher than the bottom face 567 of foam chamber 511, thereby forming a step portion 562. Step portion 562 receives the lower portion of porous member 520 so that the portion of porous member 520 in the vicinity of communicating hole 519 is compressed. When required, a slope 563 which is directed from the ink chamber 512 to the foam chamber 511 may be formed to aid in the supply of ink. Since slope 563 allows ink in ink chamber 512 to flow more easily toward foam chamber 511, irrespective of the inclination of the carriage, ink from ink chamber 512 can be constantly supplied to the recording head.

Reference is now made to Figures 11 and 12 which depict an ink jet cartridge constructed in accordance with a fifth embodiment of the invention. Like structures are indicated by like reference numerals, the primary difference between this embodiment and the first embodiment is the formation of a through hole. This embodiment is the same as shown in Figures 4 and 5.

Groove 519a (Figures 4 and 5) is formed in the face of centre partition 510 separating foam chamber 511 from ink chamber 512. Groove 519a is formed in the face of partition 510 on the side of the foam chamber 511 and is in communication with the upper portion of communicating hole 519 of centre partition 510 within the respective chambers 511, 512. In order to allow air to pass from ink chamber 512 to foam chamber 511 and to retain these chambers in fluid communication with each other, a through hole 519b is formed in the lower end of the groove 519a. Thus, the upper portion of porous member 520 which exhibits a relatively small capillary force is maintained in fluid communication with communicating hole 519 via the space formed by thin groove 519a. Therefore, ink can be smoothly replaced with air so that ink in ink chamber 512 constantly flows into foam chamber 511, thereby preventing too much or not enough ink from being supplied.

Reference is now made to Figures 13 and 14 which depict an ink cartridge constructed in accordance with a sixth embodiment of the invention. Like numerals are utilized to depict like structures, the primary difference being the use of a projection into foam chamber 511.

A horseshoe-shaped projection 565 is formed on the bottom of foam chamber 511 as is shown in Figure 14. Projection 565 ensures a space in the vicinity of communicating hole 519 so that ink from ink chamber 512 can easily flow into foam chamber 511.

As described above, foam chamber 511 and ink chamber 512 are separated from each other by the single centre partition 510. In seventh or eighth embodiments of a single-colour ink cartridge, as shown in Figures 15 and 16 respectively, an ink chamber 571 may be formed so as to surround two or three sides of a foam chamber 570, and a communicating hole 573 may be formed in at least one of the walls 572 separating the foam chamber 570 from the ink chamber 571. An exit port 574 is positioned within foam chamber 570. An ink cartridge of this design can store an amount of ink which is relatively large as compared with the volume of the whole ink cartridge. Furthermore,

because of the location of the chambers, the user can easily see if replacement of the ink cartridge is required because of depletion of the ink.

Reference is now made to Figures 17 and 18 wherein an ink jet printer cartridge constructed in accordance with a ninth embodiment of the invention is provided. This embodiment is similar to the first embodiment, the primary difference being the use of a resilient O-ring 5300 which is retained in contact with the peripheral face of an ink supply needle of the recording head upon insertion of the ink supply needle into the ink supply cartridge. However, this ink jet printer results in other problems solved by the first embodiment. A large frictional force may be produced when mounting the cartridge on the carriage and inserting the ink supply needle into the cartridge. This results in an extra strain on the recording head and the carriage. Furthermore, O-ring 5300 is supported at its periphery by the body 5302 of the cartridge. If there is a misalignment between the cartridge and the ink supply needle of the recording head upon insertion of the ink supply needle in the ink supply cartridge, it is very difficult to mount the cartridge. Furthermore, when a three colour ink cartridge in which tanks 5304, 5306 and 5308 for the three colour inks are integrated into one piece as shown in Figure 18, it is extremely difficult to mount such a cartridge on the recording head if the cartridge and any of the ink supply needles are misaligned.

It will thus be seen that the objects set forth above, among those made apparent from the preceding description are efficiently attained and, since certain changes may be made in carrying out the above construction and method set forth without departing from the spirit and scope of the invention as defined by the claims, it is intended that all matter contained in the above description and shown in the accompanying drawings shall be interpreted as illustrative and not in a limiting sense.

CLAIMS

1. An ink tank cartridge for an ink-jet type recording apparatus, comprising:

a chamber;

an ink supply port extending through a wall of said chamber and supplying ink to the exterior of said cartridge;

a porous member in said chamber positioned to deliver ink to the ink supply port; and

a plurality of projections formed on an inside wall of said chamber disposed on a surface of said chamber opposite said ink supply port, said projections compressing said porous member against said ink supply port and at least one projection directly opposed the ink supply port being formed with its free end located at a position closer to the ink supply port than the free end of a projection or projections not directly opposite the ink supply port, whereby the portion of porous member in the vicinity of the ink supply port is compressed to a greater extent than the portion of porous member remote from the ink supply port.

2. An ink tank cartridge for an ink-jet type recording apparatus, comprising:

a first chamber;

a second chamber;

a partition wall disposed in said cartridge and being formed with a communicating hole formed therein disposed between said chambers, said communicating hole extending along a relatively small portion of the bottom of said partition wall substantially away from the lateral extremes thereof, said second chamber communicating with said first chamber through said communicating hole;

an ink supply port extending through a bottom wall of said second chamber, projecting into said second chamber and supplying ink to the exterior of said cartridge, said ink supply port terminating within the second chamber in an enlarged internal bore compared with the bore passing through the said bottom wall;

a porous member in said second chamber positioned to deliver ink to the ink supply port; and

an air vent port communicating between said second chamber and the exterior of said cartridge at a location spaced from said ink supply port and communicating hole.

3. An ink tank cartridge for an ink-jet type recording apparatus, comprising:

a first chamber;

a second chamber;

a partition wall disposed in said cartridge and being formed with a communicating hole formed therein disposed between said chambers, said communicating hole extending along a relatively small portion of the bottom of said partition wall substantially away from the lateral extremes thereof, said second chamber communicating with said first chamber through said communicating hole;

an ink supply port extending through a bottom wall of said second chamber, projecting into said second chamber and supplying ink to the exterior of said cartridge, said ink supply port terminating within the second chamber at a height which is above the highest extreme of the said communicating hole;

a porous member in said second chamber positioned to deliver ink to the ink supply port; and

an air vent port communicating between said second chamber and the exterior of said cartridge at a location spaced from said ink supply port and communicating hole.

4. An ink tank cartridge for an ink-jet type recording apparatus, comprising a housing with an ink supply port extending through an external wall thereof for supplying ink from the housing to the exterior thereof, wherein a funnel-shaped packing member is provided within the ink supply port, the member having a tapered bore for receiving an ink supply needle of an ink recording apparatus and resiliently abutting there against so as to form a seal.

Amendments to the claims have been filed as follows

1. An ink tank cartridge for an ink-jet type recording apparatus, comprising:

a first chamber;

a second chamber;

a partition wall disposed in said cartridge and being formed with a communicating hole formed therein disposed between said chambers, said communicating hole extending along a relatively small portion of the bottom of said partition wall substantially away from the lateral extremes thereof, said second chamber communicating with said first chamber through said communicating hole;

an ink supply port extending through a bottom wall of said second chamber, projecting into said second chamber and supplying ink to the exterior of said cartridge, said ink supply port terminating within the second chamber in an enlarged internal bore compared with the bore passing through the said bottom wall;

a porous member in said second chamber positioned to deliver ink to the ink supply port; and

an air vent port communicating between said second chamber and the exterior of said cartridge at a location spaced from said ink supply port and communicating hole.

2. An ink tank cartridge for an ink-jet type recording apparatus, comprising:

a first chamber;

a second chamber;

a partition wall disposed in said cartridge and being formed with a communicating hole formed therein disposed between said chambers, said communicating hole extending along a relatively small portion of the bottom of said partition wall substantially away from the lateral extremes thereof, said second chamber communicating with said first chamber through said communicating hole;

an ink supply port extending through a bottom wall of said second chamber, projecting into said second chamber and supplying ink to the exterior of said cartridge,

said ink supply port terminating within the second chamber at a height which is above the highest extreme of the said communicating hole;

a porous member in said second chamber positioned to deliver ink to the ink supply port; and

an air vent port communicating between said second chamber and the exterior of said cartridge at a location spaced from said ink supply port and communicating hole.